origin of the frenate type from an earlier type which was essentially jugate, but which possessed frenulum-like structures of a character to be easily developed, by selection, into the existing highly specialized frenate condition of the wings of the Noctuidæ and others.

In conclusion, I may add that every attempt I have yet made to study, in a comparative way, the morphology of the three insect groups mentioned in this paper, has afforded in each succeeding instance stronger basis for a belief in the close phyletic relationship of the groups, a belief shared with, of course, and already expressed by many others.

Stanford University, Calif.

ON THE PRESENCE OF FLUORINE AS A TEST FOR THE FOSSILIZATION OF ANIMAL BONES.

By Dr. Thomas Wilson.

(*Continued from page 456, Vol. XXIX*).

Appreciating the importance of the discoveries made in France in regard to the proportion of fluorine in animal bones as a test of their fossilization and antiquity, I determined to make a further attempt in the investigation by analysis of the bones, human and mylodon, found by Dr. Dickeson at Natchez, as heretofore described (page 303). To that end, I made application to Dr. Samuel G. Dixon, Curator of the Academy of Natural Sciences of Philadelphia, for specimens of the two bones to be subjected to analysis with a view to the determination of their respective proportions of fluorine. Dr. Dixon kindly presented my application, and it was allowed. In due course I received the fragments from the two respective bones. Professor R. L. Packard was engaged in the laboratory in the U. S. National Museum making a series of mineral and rock analyses, we had, together, become acquainted with Mons. Car-

not's methods of analysis by having read and studied them, and he was heartily enlisted in the investigation, therefore was chosen to make the analyses. His report is herewith presented :—

WASHINGTON, D. C., March 20, 1895.

Dr. Thomas Wilson, Curator, Department of Prehistoric Anthropology, Smithsonian Institution.

DEAR SIR : I send you herewith the results of the chemical analyses of the fragments of bones you gave me for examination.

One of the specimens, said to be a portion of the mylodon gave on complete analysis the following composition :

Moisture,	3.94
Organic matter,	25.55
Carbonic acid (CO_2),	3.76
Lime ($Ca\ O$),	28.25
Magnesia (MgO),	.06
Manganese (MnO),	.79
Oxide of Iron and Alumina (Fe_2O_3 & Al_2O_3),	7.75
Phosphoric acid (P_2O_5),	26.59
Fluorine (Fl),	.28
Insoluble matter,	1.55
	98.51

From the nature of the case the determinations were made on different pieces of bone, and its composition seems to be tolerably uniform, because duplicate determinations of moisture, carbonic acid and organic matter varied very little.

Arranged to show the combination of the above bases and acids, for which a separate determination of the iron (and alumina) phosphate were made, the result is :—

Moisture,	3.94
Organic matter,	25.55
Calcium carbonate,	8.54
Calcium phosphate,	42.83
Iron (and alumina) phosphate,	12.07

Magnesium phosphate, ...	.13
Calcium fluoride, ...	.57
	93.63

The specimen said to be fragments of the human pelvis consisted of a disk of perhaps an inch in diameter and a quarter of an inch thick, pieces of what appeared to have been another disk similar to the first, and a quantity of coarse powder. That the two were not identical in composition is evident from the difference in the loss on ignition, the solid pieces having given 25.05 and the powder 14.20 per cent.

As the determination of fluorine was a special object in this investigation, I decided to use only the solid pieces of the bone, as this would afford a better means of comparison with the mylodon bone. This was accordingly done, and the following was the result of the partial analysis which was carried out on the same sample in which the fluorine was determined:

Moisture, ...	3.62	
Organic matter, ...	21.43	
Iron (and alumina) phosphate, . .	13.01	
Lime (Ca O), ...	27.94	
Phosphoric acid (P_2O_5), ...	20.77	
Fluorine, ...	.38	(=.78 Ca F_2)

It was impossible to determine the carbonic acid. The insoluble residue was slight, but was not determined.

Deducting the moisture and organic matter, we should get for the composition of the ash of the mylodon:—

Calcium carbonate, ...	13.14
Calcium phosphate, ...	65.92
Iron (and alumina) phosphate, ...	18.57
Calcium fluoride, ...	.88

We have not sufficient data for making a similar complete calculation in the case of the human bone, but we can give

enough of the constituents to find in it, as well as in the mylodon bone, the ratio between the fluorine contained in the bones and the theoretical quantity which an apatite having the same proportion of phosphoric acid would contain, as recommended by M. Carnot in the Ann. des Mines, 1893.

Deducting the moisture and organic matter, therefore, we should have the following partial composition of the ash of the human bone:—

Iron (and alumina) phosphate, ...	17.34
Lime (Ca O), ...	37.25
Total phosphoric acid, ...	27.69
Fl (fluorine), ...	0.51
Or Ca Fl (calcium fluoride), ...	1.03

The analyses are here re-arranged so as to permit of comparison with those tabulated by M. Carnot:—

Ash	Organic matter	Oxide of Iron (and alumina)	Phosphoric acid	Fluorine	Fluorine of apatite	Ratio { Fluorine and Fluorine of Apatite }
Mylodon	22.55	7.75	26.59	0.28	2.37	0.12
Human bone	21.43	6.50	20.77	0.38	1.85	0.20

In the present instance the fluorine was determined by the method recommended by M. Carnot with no essential modifications. This method differs from others mainly in the composition of the precipitate produced. The process, in brief, consists in decomposing the substance mixed with silica (free from fluorine) with concentrated sulphuric acid which has been freed from fluorine by heating with silica, passing the silicon fluoride gas evolved through dry tubes unto a solution of fluoride of potassium, and precipitating the fluo-silicate of

potassium so produced with alcohol, which precipitate is collected on a tared filter dried and weighed. The decomposition is effected in a dry flask at a temperature of about 100° C and the current of dry air is passed through the apparatus during the operation, which lasts a couple of hours or more. I examined the precipitates under the microscope in order to be certain of their character, and observed the small isometric forms—combinations of cubes and octahedrons—under which silicofluoride of potassium appears.

The analyses of the human bone and mylodon which you had made formerly and have handed me, show that the specimens differed in several respects from those you furnished me. The composition of the mylodon bone does not vary so very much in its essential constituents from that I have analyzed, but the human bone contained 22.59 per cent. of silica. Deducting that figure from the total, and recalculating, we have:

Loss on ignition, ...	20.15
Lime, ...	33.59
Phosphoric acid, ...	22.57

This makes the proportion of lime about six per cent. greater than in the specimen I analyzed, while the phosphoric acid is only some two per cent. higher. In both cases that latter constituent is present in much smaller proportion than is usually given for phosphoric acid in human bones. (See Fremy, Encyclopedie Chimique T. IX, p. 603, where phosphoric acid is as high as 53 per cent. of the ash or total mineral matter). Moreover, the percentage of ash is higher than is usual in human bones. A list in Watts' Dictionary, article Bone, gives the percentage of ash in such bones as below 70 per cent., ranging from about 50 to 70, while in the present case the ash is about 75 per cent.

I am
Very truly yours,
(Signed) R. L. PACKARD.

It is always to be remembered throughout this paper, both in the investigations of myself and Dr· Packard, as well as in

those of Mons. Carnot, that the results are comparative and not absolute. The value of our investigations lies in showing that if the bones of the mylodon and the man were originally deposited together, and were practically the same age, they must have been subjected to substantially the same chemical influences, they would show practically the same analyses, and the comparison between their respective constituents should be substantially the same. Thus is afforded the great desiderata of a means of comparison between the human and the animal bone. As it is known that the mylodon was to a certain extent an ancient animal, if the human bone, when compared with that of the mylodon showed an equal amount of fluorine together with the concomitants of fossilization, it is evidence that they are of the same antiquity.

The relations between the various chemical constituents of the two bones are shown in the following table:

	Mylodon	Man
Fluorine, ...	0.28	0.38
Fluorine calculated for apatite, .	2.37	1.85
Ratio, ...	0.102	0.205
Phosphoric acid, ...	26.59	20.77
Fluorine, ...	0.28	0.38
Ratio, ...	94.96	54.70
Organic matter, ...	25.55	21.43
Oxide of iron and alumina, . .	7.75	6.50

From these tables the following comparisons may be made: The fluorine in the mylodon was 0.28, in man 0.38, the ratio between the quantity of fluorine in the bone and to that of an apatite having an equal amount of phosphoric acid was, for the mylodon 0.102, for the man 0.205. A reference to the tables on pages 313 and 447 will show that for modern bones, the average as calculated from twelve specimens, is 0.058. By the same table the Quaternary bones were shown to be 0.36. It would appear from a comparison, that the bones of the man and the mylodon subjects of the present analyses are approximately between modern bones and those of the Quaternary period.

In the present cases the phosphoric acid was in the mylodon 26.59 and the man 20.77, while the fluorine was respectively 0.28 and 0.38, making the ratio between them, for the mylodon 94.96, for the man 54.70. Referring to page 455, we will see this test applied to the discoveries of Billancourt. There the two fossil bones were respectively 23.9 and 19.4, while the human bone reached the high average of 168.9. Turning again to the table on page 447, we will see that this ratio was increased in the case of bones known to be modern to 193.1. This, therefore, bears out the contention of the value of this test—it shows two things, (1) that according to the averages made by Mons. Carnot, the bones under present consideration, the man and the mylodon, are substantially of the same antiquity, and (2) by the same comparison their antiquity is about midway between the modern bones and those of the Quaternary geologic epoch.

This investigation will be carried further by making analyses of other bones, some of which will be modern, some of known, and others of supposed antiquity.

CONTRIBUTIONS TO COCCIDOLOGY.—I.

By T. D. A. Cockerell,

ENTOMOLOGIST, NEW MEXICO AGR. EXP. STATION.

The present is the first of a proposed series of papers on Coccidæ (Scale Insects); intended to make known some of the numerous new facts, especially regarding their distribution, which are constantly coming to light. The ever increasing traffic in living plants, which is going on in nearly every part of the world, is leading to the wide dispersal of injurious Coccidæ. No one who has not given particular attention to this matter can realize the serious nature of the situation, from an economic point of view. Not only is the number of harmful Coccidæ in each locality being greatly increased by importations, but, as is well-known, the imported species often show a